Module V. Neuropsychological Assessments

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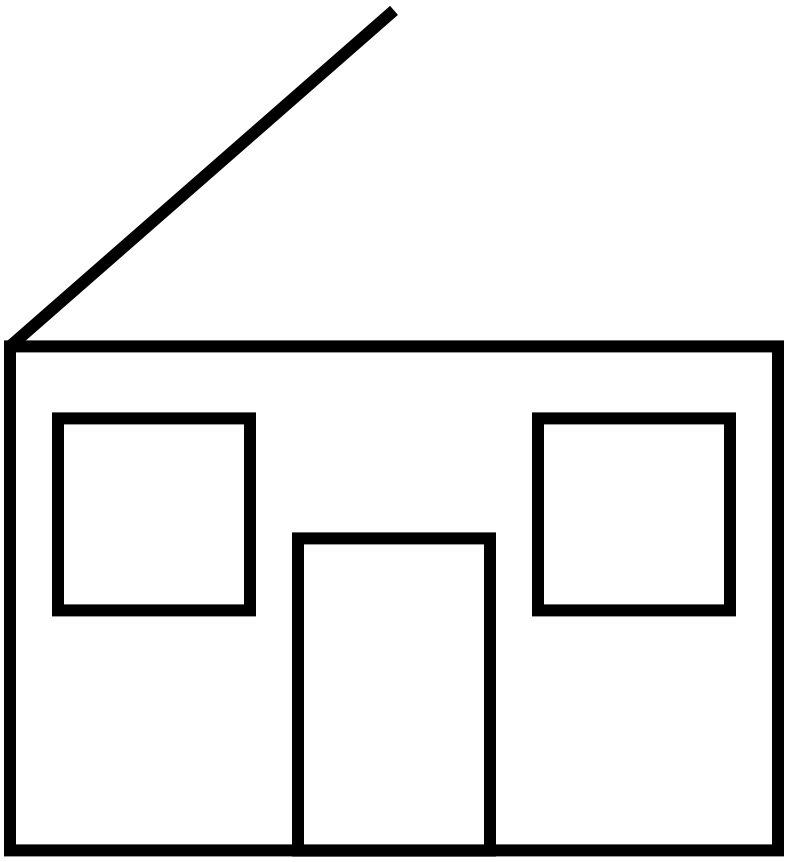

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Instructions to This Module:

- If you have questions we encourage you to talk to your supervisor or you can call the ABI Program Manager under (801) 538-8244.

Objectives of This Module:

a) Understand what a Neuropsychological Assessment is.
b) Understand what indicates a Neuropsychological Assessment.
c) Understand what Neuropsychological Assessments measure.
d) Understand the tests used in Neuropsychological Assessments.
e) Understand the purpose of the tests.

Clinical Neuropsychology 101 (An Introduction)

The clinical specialty of neuropsychology bridges interest in the biological function of neural cells in the brain, spinal cord, and body with the study of psychological disorders. The neuropsychologist uses objective, scientific techniques to link behaviors to underlying normal and abnormal biological (i.e., brain) processes. The clinical neuropsychologist studies patterns of abnormal behavior to infer the biological abnormalities that might be producing or contributing to those behaviors.

Traditionally defined, neuropsychology is the study of (and the assessment, understanding, and modification of) brain-behavior relationships. Neuropsychology seeks to understand how the brain, through structure and neural networks, produces and controls behavior and mental processes, including emotions, personality, thinking, learning and remembering, problem solving, and consciousness. The field is also concerned with how behavior may influence the brain and related physiological processes, as in the emerging field of psychoneuroimmunology (the study that seeks to understand the complex interactions between brain and immune systems, and the implications for physical health).

Neuropsychology seeks to gain knowledge about brain and behavior relationships through the study of both healthy and damaged brain systems. It seeks to identify the underlying biological causes of behaviors, from creative genius to mental illness, that account for intellectual processes and personality. *Clinical* neuropsychology seeks such understanding, particularly in the case of how damaged or diseased brain structures alter behaviors and interfere with mental and cognitive functions.

The neuropsychologist uses objective tools--neuropsychological tests--to tie the biological and behavioral aspects together. Through the use of tests, the clinical neuropsychologist is able to differentiate whether or not a behavioral abnormality is more likely caused by a biological abnormality in the brain or by an emotional or learned process.

If we presume that the brain is the starting point for why and how we process *all* mental information (not just cognitive, but interpersonal communications, self-concept, emotional reactivity, personality, learned responses, etc.), then in some aspect, all psychology is *neuro*psychology. Neurolinguistics, for example, is the study of how language shapes our self-concepts and our interpersonal communications. Neurodevelopmental psychology is the study of how behavioral and mental characteristics change with nervous system growth. Even psychological concepts of dreaming (and dream content), level of attention, and conscious experience are subserved by brain processes.

Neuropsychology is a structured, objective, and scientific discipline for peeking into individual brains by way of formally observing behaviors. Clinical neuropsychology seeks, ultimately, to understand the *individual* mind and brain (and its normal as well as errant behaviors). The discipline uses experimental and objective procedures to

compare performance among persons with known differences in their biological brain structures (within the limited criteria currently available for defining these differences), and to search for the myriad sources of brain variance that produce individual differences in behavior. These sources include biological factors (e.g., genetic, diseases, and injuries) as well as psychological factors (e.g., learned behaviors and personality) and social factors (e.g., economics, family structure, and cultural values).

In the application of *clinical* neuropsychology, understanding the biological sources of individual differences, particularly, helps identify brain-based disorders in memory, personality, self-awareness (conscious experience), cognition, and emotional expression. Working backwards, then, from a look at abnormal behavior obtained using formal tests, reasonable inferences about brain disorders can be reached. Understanding these neurofunctional changes (i.e., abnormalities) as a result of brain changes (i.e., injury) defines parameters for current and future behavioral expectations in the lifestyle of the individual. Combined with additional understanding of biopsychosocial factors that coalesce into behavioral expression, the neuropsychologist can gain a comprehensive impression of what is normal or abnormal behavior. As our knowledge of recovery from brain injury improves, such understanding provides realistic expectations for remediation (restoration or adjustment) of disordered behavior.

Neuropsychological understanding is achieved through a comprehensive exploration of the neurophysiological foundation of behavior and seemingly infinite potential contributing factors. Everyone's brain is wired differently, a product of native biological structure, past experiences, physical health, learned responses and personality, injuries and diseases, and a host of other factors. Clinically, it is the role of the neuropsychologist to sort out the factors that influence how the brain is working in order to understand disease expression, progress, and recovery.

Capsule Description of the Clinical Neuropsychological Assessment

Clinical neuropsychology is . . .

- the study of how functional skills (e.g., memory, language, attention, reading, planning, visual-spatial analysis, problem-solving, and so forth) change and impact daily life as a result of brain dysfunction from injury and disease;
- the study of the interrelatedness of mental processes and how injury to one brain system may adversely influence the functioning of other, non-injured brain systems;
- the determination of brain diagnosis based, in part, on results of objective psychological tests sensitive to brain injury or disease, compared with normative performance of non-injured individuals on the same tests;
- the analysis of life-consequences of brain injury or disease and the processes by which people may recover from dysfunction and/or adapt to disabilities caused by permanent dysfunction.

Neuropsychological assessment is . . .

- the administration of objective psychological tests and related procedures that are proven sensitive to the effects of brain injury;
- the selection of examination procedures that are specific for measuring functional changes due to impairment of specific cognitive domains;
- the integration of statistical and observational findings, and history, that may reveal a logically consistent pattern commonly seen with specific brain disorders;
- the process of tying together psychosocial history, personality, medical and physical health history, and mechanisms of brain injury in order to make sense of present mental functioning and clinical presentation;
- the determination of rehabilitation needs based on the measured strengths and weaknesses in functional domains and the lifestyle of the individual.

Neuropsychological Screening for Brain Dysfunction

Normally, a neuropsychological examination explores in depth an individual's performance in a wide range of functional domains. There are instances, however, in the early phases of diagnostic exploration when the presence of a brain injury or disease is not compelling but when a suspicion reasonably might be considered. In such cases, along with other diagnostic procedures, a neuropsychological screening examination may be employed. A neuropsychological screening examination is a considerably abbreviated version of a full neuropsychological assessment, looking only at key sensitive areas of function.

The purpose of a neuropsychological screening examination is to determine if there is reasonable evidence, beyond initial clinical impression, for a diagnosis of brain injury or brain disease. Even though it is "screening," the examination must be definitive in this regard. To miss a neurological diagnosis on the basis of a screening examination could be quite unfortunate. Once a screening points to reasonable probability that a neurological condition exists, a full neuropsychological examination would be indicated to attain further diagnostic, prognostic, and treatment planning information. A referral for neurological examination would also be appropriate at this point.

Both screening and full neuropsychological examinations offer the opportunity for diagnosis of probability of brain dysfunction (as opposed to diagnosis of psychodynamic, personality, and/or emotional disorder not associated with neurological causes). For a screening examination, assessing probability of brain dysfunction is about as far as the diagnosis goes. A full neuropsychological examination, on the other hand, is necessary to delineate the wide variety of functional manifestations of brain damage or disease. Such detail is necessary to understand the life consequences of functional impairment (e.g., work, school, relationships, driving potentials, competency, and so forth).

Ability to understand personality, mental health, and behavioral characteristics of the individual when there is a brain injury requires a full neuropsychological examination. A broad range of functional domains must be evaluated. Also, designing a cognitive, rehabilitative, or psychological treatment program for a person with brain injury or disease requires comprehensive understanding of broad neuropsychological characteristics.

Formal neuropsychological testing is typically a relatively minimal component of a screening examination. The psychologist performing a screening examination may rely as much on history, behavioral observations, patterns of subjective complaints, and other history to establish a reasonable suspicion of an organic pathological state of the brain.

Screening neuropsychological examination is indicated when:

- situational explanation for changes in emotions or cognitive functioning cannot be readily identified;
- a medical or injury condition is suspected to have impacted brain health (for example, compromised circulation, chronically poor nutrition, or drug toxicity);
- any relatively sudden, unexpected, and unaccounted for changes appear in mental or cognitive performance that impacts work or daily functioning;
- gradual or sudden onset of unusual physical, sensory, or motor changes (an examination by a physician is always indicated in these instances, as well);
- an individual fails to improve with special educational or therapeutic interventions designed to address a specific mental or cognitive problem.

Full neuropsychological examination is indicated when:

- screening examination is positive for likelihood of brain disorder;
- a brain injury or disease is already known and comprehensive understanding of functional impact is desired;
- a brain injury or disease is highly suspect and comprehensive neurofunctional characteristics are desired to complement neurological examination and diagnostic understanding;
- comprehensive diagnostic and functional nature of brain injury or disease is necessary for rehabilitation and life-long planning;
- comprehensive diagnostic, functional, and causative nature of brain injury or disease is necessary for forensic application;
- complex diagnostic efforts require careful, objective, and often serial measurement of neurofunctional performance across cognitive domains.

What Do Neuropsychological Tests Measure?

A neuropsychological assessment consists of administering tests that examine a set of more-or-less independent functional domains that are controlled by brain systems. While neuropsychologists agree on a general range of functional domains, some categories may be combined in different examinations. Nevertheless, neuropsychological assessment generally taps most of these areas of functioning that potentially may be impacted by brain disorders.

Attention and Processing Speed -- The capability to focus and sustain attention in mental activity is reflected in processing speed, simple accuracy in a sustained focus task, divided thinking among tasks, mental manipulation and control, and resistance to internal or external distraction.

Motor Performance -- The ability to perform gross and fine motor tasks, and the ability to perform purposeful tasks is of particularly significant interest in evaluating differences between the two sides of the body. Apraxia refers to the inability to perform a movement resulting from a neurological defect.

Sensory Acuity -- The ability to detect basic visual, auditory, and tactile sensations is critical to processing information at higher levels.

Working Memory -- Working memory is closely related to attention in that it involves keeping a limited amount of information active, frequently up-dated, and rapidly accessible for a brief time span. Most people have a working memory capacity of about seven items.

Learning and Memory -- The ability to *encode* new information, *store* information in a relational memory system, and *retrieve* information is measured in verbal/auditory and in spatial/visual modalities.

Intelligence -- Intelligence is a summary and multifaceted concept of general mental capability, reflecting the ability to comprehend, adapt to, and interact with the environment. Patterns among components of intelligence, those reflecting "hold" versus "don't hold" skills, provide a strong basis for inferring changes in current intelligence from inferred premorbid intelligence. Intelligence is not a specific domain but a composite of several domains. It is usually included in neurofunctional assessment, however, as a comprehensive functional index and, because it is multifaceted, may not reflect some forms of brain injury or disorder.

Language -- The ability to receive and express thought through various forms of symbolic manipulation is measured in various language tests. Receptive language is measured in reading and ability to comprehend spoken language. Expressive language is measured in writing and ability to formulate oral language.

Calculation -- Ability to manipulate mathematical symbols and perform operations may reflect skill level or loss of skills the individual once had. The specific nature of calculation difficulties can suggest specific areas of brain dysfunction.

Visuospatial Analysis -- The ability to receive, interpret, and apply meaning to visual information is measured in constructional skills and visual perceptual tests.

Problem Solving and Judgment -- Problem solving refers to advanced, higher-order information processing where knowledge is assessed and manipulated to find solutions to problems and make informed and reasoned judgments. Arithmetical thinking is a kind of problem solving.

Abstract Thinking -- The ability to use generalized information and apply it to specific situations involves abstract or conceptual thinking.

Mood and Temperament -- The ability of the individual to function in daily living situations depends on cognitive style, personality traits, beliefs, comportment, mental organization, and emotional status and variability.

Executive Functions -- Metacognition is the ability to achieve insight and self-awareness; to reflect on, initiate, evaluate, and regulate (activate and inhibit) thinking and behavior; to think flexibly; and to make decisions integrating judgment and feedback.

Tests Commonly Used In a Neuropsychological Examination

Neuropsychologists use scientifically validated objective tests to evaluate brain functions. While neurological examination and CT, MRI, EEG, and PET scans look at the structural, physical, and metabolic condition of the brain, the neuropsychological examination is the only way to formally assess brain *function*. Neuropsychological tests cover the range of mental processes from simple motor performance to complex reasoning and problem solving. In almost all objective tests, **quantitative** results are compared with some normative standard, including data from groups of non-brain injured persons and groups of persons with various kinds of brain injury. If the norms are based on age and educational achievement, valid comparison can be made between an individual's performance and that of persons in known diagnostic categories as well as persons who do not have a diagnosis of brain injury.

Qualitative assessment of neuropsychological tests provides a look at the *processes* an individual may use in producing the quantitative scores. Analysis of the pattern of performance among a large number of tests is key to a neuropsychological assessment. Thus, the selection of tests used in a neuropsychological test battery should sample a wide range of functional domains. The combination of objective scores, behavioral process observations, and consistency in emerging pattern of results, along with

comprehensive clinical history, constitute the art and science of neuropsychological assessment. Most neuropsychologists select a unique combination of tests focused on the diagnostic and examination questions of interest for an individual.

The following alphabetical listing includes some of the more frequently used tests employed in a neuropsychological assessment. Brief descriptions indicate the intent of each test . Some tests are included here that are not, strictly speaking, neuropsychological tests, but that may be used in a comprehensive examination. In order to keep test content and applications confidential to preserve their clinical usefulness, this information is restricted to general comments.

Test Name	Purpose of Test
Ammons Quick Test	This test has been used for many years to help assess premorbid intelligence. It is a passive response picture-vocabulary test.
Aphasia Tests (various)	Several aphasia and language tests examine level of competency in receptive and expressive language skills. (e.g., Reitan-Indiana Aphasia Screening Test)
Beck Depression or Anxiety Scales	These scales provide quick assessment of subjective experience of symptoms related to depression or anxiety.
Bender Visual Motor Gestalt Test	This test evaluates visual-perceptual and visual-motor functioning, yielding possible signs of brain dysfunction, emotional problems, and developmental maturity.
Boston Diagnostic Aphasia Examination	Broad diagnosis of language impairment in adults.
Boston Naming Test	Assessing the ability to name pictures of objects through spontaneous responses and need for various types of cueing. Inferences can be drawn regarding language facility and possible localization of cerebral damage.
California Verbal Learning Test	This procedure examines several aspects of verbal learning, organization, and memory. Forms for adults and children.
Cognitive Symptom Checklists	Self-evaluation of areas of cognitive impairment for adolescents and adults.

Continuous Performance Test	Tests that require intense attention to a visual-motor task are used in assessing sustained attention and freedom from distractibility. (e.g., Vigil; Connors Continuous Performance Test)
Controlled Oral Word Association Test	Different forms of this procedure exist. Most frequently used for assessing verbal fluency and the ease with which a person can think of words that begin with a specific letter.
Cognistat (The Neurobehavioral Cognitive Status Examination)	This screening test examines language, memory, arithmetic, attention, judgment, and reasoning. It is typically used in screening individuals who cannot tolerate more complicated or lengthier neuropsychological tests.
d2 Test of Attention	This procedure measures selective attention and mental concentration.
Delis-Kaplan Executive Function System	Assesses key areas of executive function (problem-solving, thinking flexibility, fluency, planning, deductive reasoning) in both spatial and verbal modalities, normed for ages 8-89.
Dementia Rating Scale	Provides measurement of attention, initiation, construction, conceptualization, and memory to assess cognitive status in older adults with cortical impairment.
Digit Vigilance Test	A commonly used test of attention, alertness, and mental processing capacity using a rapid visual tracking task.
Figural Fluency Test	Different forms of this procedure exist, evaluating nonverbal mental flexibility. Often compared with tests of verbal fluency.
Finger Tapping (Oscillation) Test	This procedure measures motor speed. By examining performance on both sides of the body, inferences may be drawn regarding possible lateral brain damage.
Grooved Pegboard	This procedure measures performance speed in a fine motor task. By examining both sides of the body, inferences may be drawn regarding possible

	lateral brain damage.
Halstead Category Test	This test measures concept learning. It examines flexibility of thinking and openness to learning. It is considered a good measure of overall brain function. Various forms of this test exist.
Halstead-Reitan Neuropsychological Battery	A set of tests that examines language, attention, motor speed, abstract thinking, memory, and spatial reasoning is often used to produce an overall assessment of brain function. Some neuropsychologists use some or all of the original set of tests in this battery.
Hooper Visual Organization Test	This procedure examines ability to visually integrate information into whole perceptions. It is a sensitive measure of moderate to severe brain injury.
Kaplan Baycrest Neurocognitive Assessment	Assesses cognitive abilities in adults, including attention, memory, verbal fluency, spatial processing, and reasoning/conceptual shifting.
Kaufman Functional Academic Skills Test	A brief, individually administered test designed to determine performance in reading and mathematics as applied to daily life situations.
Kaufman Short Neuropsychological Assessment	Measures broad cognitive functions in adolescents and adults with mental retardation or dementia.
Luria-Nebraska Neuropsychological Battery	This is a set of several tests designed to cover a broad range of functional domains and to provide a pattern analyses of strengths and weakness across areas of brain function. The tests reflect a quantitative model of A. R. Luria's qualitative assessment scheme.
MMPI-2 (Minnesota Multiphasic Personality Inventory)	This well-known and well-respected personality assessment is often used to accompany neuropsychological tests to assess personality and emotional status that might lend understanding to reactions to neurofunctional impairment.
Memory Assessment Scales	This is a comprehensive battery of tests assessing short-term, verbal, and visual memory.

MicroCog	This computerized assessment measures nine functional cognitive areas sensitive to brain injury
Millon Clinical Multiaxial Inventory	A self-report assessment of personality disorders and clinical syndromes. This is sometimes used as an adjunct instrument in comprehensive neuropsychological assessment.
Mooney Problem Checklist	This instrument helps individuals express their personal problems. It covers health and physical development; home and family; morals and religion; courtship, sex, and marriage.
Multilingual Aphasia Examination	This set of subtests provides comprehensive assessment of a wide range of language disorders.
North American Reading Test	This reading test is often used to help assess premorbid intelligence, for comparison with current intelligence as measured by more comprehensive tests.
Quick Neurological Screening Test	This is a rapid assessment to identify possible neurological signs, primarily in motor, sensory, and perceptual areas.
Paced Auditory Serial Attention Test	Tests for attention deficits including concentration, speed of processing, mental calculation, and mental tracking. Sensitive for diagnosing cognitive impairment in individuals 16 and up.
Paulhus Deception Scales	This instrument measures the tendency to give socially desirable responses, useful for identifying individuals who distort their responses.
Personality Adjective Checklist	This self-report measure evaluate several personality patterns, primarily focusing on personality disorders
Repeatable Battery for the Assessment of Neuropsychological Status	Designed as a brief, repeatable measure of cognitive decline or stability over time, appropriate for trauma, disease, or stroke.
Rey Auditory Verbal Learning Test	This procedure evaluates the ability to learn word lists. It is the forerunner of other tests of verbal

	learning using lists of words.
Rey Complex Figure Test	This drawing and visual memory test examines ability to construct a complex figure and remember it for later recall. It measures memory as well as visual-motor organization.
Rey 15-item Memory Test	This test is used to evaluate potential for malingering in memory.
Rey-Osterrieth Complex Figure Test	Analyzes aspects of visuospatial ability and memory in all ages.
Rivermead Behavioural Memory Test	Evaluates impairments in everyday memory related to real life situations.
Rogers Criminal Responsibility Scale	This instrument is designed to assess the impairment of an individual at the time a crime was committed.
Rorschach Projective Technique	This familiar inkblot test is used to evaluate complex psychological dynamics. Persons with brain injury have been shown to produce certain kinds of responses that can complement other tests and help to understand personality changes associated with brain injury.
Ruff Figural Fluency Test	This visual procedure complements verbal fluency tests in assessing ability to think flexibly but using visual stimuli rather than words.
Sensory Screening Test	Various procedures include the assessment of tactile sensitivity to various objects, the ability to recognize objects by touch, and the ability to detect numbers written on the hands by touch alone. By examining both sides of the body, inferences may be drawn regarding possible lateral brain damage.
SCL-90 (Symptom Checklist 90)	This checklist evaluates the individual's subjective complaints.
Shipley Institute of Living Scale	Comparison of vocabulary knowledge and ability to figure out abstract sequential patterns has been established as a sensitive measure of general brain functioning.

Stroop Test	This brief procedure examines attention, mental speed, and mental control.
Symbol Digit Modalities Test	Screening test for children and adults to detect cognitive impairment.
Tactual Performance Test	Assesses speed of motor performance, tactile perception, spatial problem-solving, and spatial memory in all ages.
Test of Memory Malingering	This test is used to evaluate potential for malingering in memory.
Test of Memory and Learning (TOMAL)	This test for children and adolescents measures numerous aspects of memory, assessing learning, attention, and recall.
Test of Memory Malingering	For ages 16-84, this visual recognition test helps discriminate malingered from true memory impairments.
Thematic Apperception Test	This projective test is most commonly used to examine personality characteristics that may aid in understanding psychological or emotional adjustment to brain injury.
Tower of London	A test for all ages, assessing higher-level problem-solving, valuable for examining executive functions and strategy planning.
Trail Making Tests A and B	These tests measure attention, visual searching, mental processing speed, and the ability to mentally control simultaneous stimulus patterns. These tests are sensitive to global brain status but are not too sensitive to minor brain injuries.
Validity Indicator Profile	A complex, computer-analyzed test for evaluating effort and motivation in test taking.
Verbal (Word) Fluency Tests (various)	There are a variety of verbal fluency tests in use. Each is designed to measure the speed and flexibility of verbal thought processes. (e.g., Controlled Oral Word Association Test; Thurstone Verbal Fluency)

Wechsler Adult Intelligence Scale—III	This set of 13 separate "subtests" produces measures of memory, knowledge, problem solving, calculation, abstract thinking, spatial orientation, planning, and speed of mental processing. In addition to summary measures of intelligence, performance on each subtest yields implications for different neurofunctional domains. The set of tests takes about an hour or more to administer. The WAIS-III is often the foundation for a comprehensive neuropsychological assessment.
Wechsler Intelligence Scale for Children—III	Comparable to the Wechsler Adult Intelligence Scale, this procedure contains subtests that measure similar domains in children.
Wechsler Memory Scale—III	This set of 18 separate "subtests" yields information about various kinds of memory and learning processes. Summary memory indices are provided in addition to the individual scores of the subtests. The whole set of tests takes about an hour to administer. The WMS-III provides a comprehensive assessment of memory. It is co-normed with the WAIS-III and is usually used in conjunction with it.
Wechsler Test of Adult Reading	Provides estimate of pre-morbid intellectual functioning in persons 18-89, normed with the WAIS-III and WMS-III.
Wide Range Achievement Test	Provides level of performance in reading, spelling, and written arithmetic. The reading and spelling tests are often used in estimating premorbid intellectual functioning.
Wisconsin Card Sort Test	Similar in concept to the Category Test, this procedure also measures the ability to learn concepts. It is considered a good measure of frontal lobe functioning.
Wonderlic Personnel Test	This personnel test is not a neuropsychological instrument per se, but is used to help evaluate vocational abilities and potential for comparison with other neuropsychological tests in making practical prognostic decisions.
Word Memory Test	A validity procedure designed to detect response

	bias that might indicate exaggeration of impairment or symptom feigning.

REVIEW

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Indications for neuropsychological assessment

ABSTRACT

A neuropsychological evaluation can help in narrowing the differential diagnosis of cognitive dysfunction, choosing treatments, and evaluating the efficacy of an intervention on an ongoing basis. In patients with documented neurologic disorders, information from neuropsychological assessment can define the patient's functional limitations or residual cognitive strengths. Proper use of neuropsychological assessment can improve the quality of care.

KEY POINTS

A referral for neuropsychological assessment is appropriate whenever there is doubt about a patient's cognitive functioning or competency.

Neuropsychologists assess a broad range of cognitive domains, not just memory.

Neuropsychological assessment can detect pathological processes before structural abnormalities are observable on neuroimaging and in cases where no abnormalities can be visualized.

Imaging studies can specify the location of many structural lesions, but the functional implications of brain pathology can be identified only through neuropsychological testing.

MS. SMITH, a 57-year-old woman, presents to her primary care physician because she is concerned about short-term memory loss. She began to notice the problem approximately 1 year ago, and it has been getting steadily worse. Her memory difficulty is affecting her performance at work and causing substantial embarrassment for her.

Family members say they have also noticed that the patient has some difficulty remembering information over the short term, but that she can recall long-ago events.

Ms. Smith has a history of hypertension that has been moderately controlled to this point. Her husband died unexpectedly approximately 3 years ago.

She is oriented to place, person, and time, she is aware of current events, and she scores 29 (of a possible 30) on the Folstein Mini-Mental State Examination (MMSE). Her lone error on the MMSE is the inability to recall one of three words.

SCOPE OF THIS PAPER

In an age of positron emission tomography and magnetic resonance imaging of the brain, what can old-fashioned paper-and-pencil neuropsychological testing still contribute to patient care?

A lot. This case, typical of many seen by primary care physicians, represents an instance in which a neuropsychological evaluation might be useful.

This article briefly describes:

- What neuropsychology is
- How it has evolved
- What a neuropsychological assessment can tell us
- When a neuropsychological assessment is indicated.

WHAT IS NEUROPSYCHOLOGY?

Neuropsychology, the intersection of neurology, psychology, and psychiatry, is an applied science that examines the behavioral manifestations of brain dysfunction.[1]

More than memory testing

Neuropsychological assessment is often seen as simply a means of testing memory, but it is more than that. A comprehensive assessment covers a range of cognitive domains, including intelligence, learning, memory, receptive and expressive language, visuospatial reasoning, motor functioning, executive functioning, and psychopathology.[1–3]

A brain injury or psychological disorder can disrupt any of these cognitive domains, which in turn can potentially affect other domains. For example, memory difficulties may be due to a poor attention span, disruption in language abilities, sensory problems, or slowed processing due to emotional disruption. All potentially contribute to the difficulty that is experienced as "memory disruption."[2,3]

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Disrupted cognition can signify many problems, in much the same way that fatigue and pain can be due to many disorders and pathologic processes. Determining the exact nature of the deficit is important.

Thorough neuropsychological assessment can provide information that might be used to refine a diagnosis, plan treatment, or establish a baseline against which improvement or deterioration can be compared.

What the patient can expect

Patients referred to a neuropsychologist spend a day taking tests of general intellect, higher-level executive skills (eg, sequencing, reasoning, problem-solving), attention, concentration, learning, memory, language, visuospatial skills, motor skills, sensory skills, mood, and personality.[4]

Many patients say that the experience is like "being back in school" or "being on a game show." The tests are not physically painful, although some patients may become mildly anxious over their performance. In those instances, redirection and reassurance generally suffice to make the patient more comfortable and reduce anxiety.

Sometimes the psychologist personally gives the tests, but other times a technician who has been thoroughly trained in administration of the measures may do it. In either case, the psychologist is responsible for interpreting the data obtained.

Most patients receive feedback from the psychologist about their performance, or from the referring physician if the evaluation is part of a larger assessment. Patients are generally told that their test scores will be compared with those of people who are similar to them in important ways. They can also be informed that the test results can be used in a number of manners, including identifying weaknesses in specific areas, differentiating among illnesses, establishing a baseline against which future assessments can be compared, and planning treatments that accommodate their functional deficits.[4]

According to the most recent practice survey by the American Psychological Association, neuropsychological evaluations typically take 4 to 8 hours (average 6). The average charge in 1990 was approximately $100/hour[5]; the current cost is likely higher. Neuropsychological evaluation is often covered by insurance when it is deemed medically necessary and is often reimbursed under the patient's medical benefit.

HISTORY OF A DISCIPLINE

The first evidence of behavioral consequences of cerebral dysfunction is from an Egyptian papyrus written between 2500 and 3000 BCE.[6]

The unknown author describes behavioral manifestations of serious head injuries in numerous patients he or she observed, including "his eye is askew…he walks with shuffling with his sole." The author also recognized the lateralization of functions, going on to state that the effects of injuries varied among different patients depending on the side of the body affected.

Later work, including that of Broca,[7] Wernicke,[8] Brodmann,[9] Penfield,[10] and Milner,[11] furthered our understanding of complex brain-behavior relationships.

Neuropsychological assessment began in earnest in the 20th century with the construc-

tion of batteries of tests aimed at identifying and evaluating the severity of behavioral deficits in patients with brain damage and aiding in diagnosis. One goal of these assessments was to pinpoint the location of brain lesions, as sophisticated neuroimaging had not yet been developed.

The most commonly used test battery was devised by Halstead and Reitan,[1,3,12] who correlated test results with findings on autopsy after the patients died. Their goal was to determine the site of lesions by noninvasive means as an aid in diagnosis.

The Halstead-Reitan battery was found useful in assessing not only severe deficits but also moderate and mild dysfunction. It also proved helpful in describing the functional deficits that arise from brain dysfunction. Furthermore, it allowed physicians to make reasoned judgments about whether the deficits observed were "organic" (ie, due to neurologic factors) or "psychiatric" (ie, due to psychological factors).

Ways of assessing cognitive function have since been expanded and refined. However, central to all approaches is the notion that the pattern of data obtained from the tests provides information about the location and effect of brain lesions and the functional deficits that accompany them.

Patients who perform well on the MMSE are not necessarily healthy

NEUROPSYCHOLOGY VS NEUROIMAGING

Now that we have the technology to image previously hidden areas of the brain, today's neuropsychologists are less often asked to deduce the location of brain lesions. Nevertheless, they still have an important role in characterizing the behavioral sequelae of brain injuries and illnesses, for several reasons:

Structure does not equal function. Neuroimaging can locate structural lesions accurately, but we cannot accurately predict the functional sequelae (the cognitive and behavioral changes that follow a neurologic insult) using structural data alone: substantial variability exists among patients with regard to their structural and functional integrity. Indeed, one could argue that, for the patient, function is more important than structure.

The nature and extent of behavioral deficits and retained abilities can be defined only through formal neuropsychological testing. The tests provide useful information about the patient's competency and decision-making capacity and have implications for the choice of treatment.

Structural changes are not always visible. Many neurologic disorders result from structural changes that are invisible to even the highest-resolution scanners. Examples include Alzheimer disease, transient ischemic attacks, many epilepsies, and many infections of the brain and spinal cord.

Neuropsychological assessment is also useful in many disorders of children in which no markers can be visualized, such as attention deficit/hyperactivity disorder, specific verbal and nonverbal learning disabilities, neurotoxic exposure, and some concussions and infectious processes.[13] In some instances, neuropsychological examinations provide objective data that help specify the diagnosis.

Even when a diagnosis can be made with specific physical markers, neuropsychology can play an important role. For example, although Down syndrome is readily identified by its physical manifestations and specific genetic abnormality (trisomy 21), neuropsychological assessment can provide invaluable prognostic information to families concerning their children's abilities.[13] Once again, the functional capabilities mean as much as the structural abnormalities, if not more.

Symptoms often precede visible structural changes.[1,2,6] If some diseases are detected early by their behavioral symptoms, physicians can often provide better care and manage symptoms better. For example, if a progressive incurable disorder such as Alzheimer disease is diagnosed early, the patient and family members have more time to plan for the inevitable deterioration in function.

Neuropsychological evaluation is useful for serial assessment, providing objective measures of progressive deterioration or recovery following traumatic brain injuries or strokes.[1–3,6]

Serial assessments are, however, confounded by repeated exposure to the test, a phenomenon called "practice effect" or "test-retest effect." To counteract this effect, researchers have estimated the amount of improvement that might be expected on vari-

ous measures as a result of repeated testing, thus allowing for more refined estimates of cognitive improvement or decline. Furthermore, neuropsychologists have developed multiple measures that tap similar functional areas without repeating specific content.[1–3]

Consequently, sometimes testing can be done numerous times over the course of a patient's treatment without duplicating measures, thereby limiting the effects of practice.

NEUROPSYCHOLOGY VS MENTAL STATUS TESTING

Short and easy-to-give tests such as the MMSE have grown in popularity as screening measures of cognitive abilities. They have the advantages of being brief, objective, and quantitative.[14]

On the other hand, although these tests give some information about the patient's general abilities, recent research suggests that they are not as useful as a thorough cognitive assessment.

Anthony et al[15] and Dick et al[16] found that the MMSE gives an overabundance of false-positive results for people over 60 years of age or with less than 9 years of education.

In addition, the MMSE has a low "ceiling." That is, even with cognitive decline, persons with high verbal intelligence quotients tend to score higher on the MMSE than the recognized cutoff score (24) that indicates cognitive impairment. Thus, those who perform well are not necessarily cognitively intact.[16]

Physicians often ask what cutoff scores suggest that a referral should be made, but the high number of false-negatives that would result from the use of cutoffs makes such recommendations inadvisable. Instead, physicians should use the MMSE to frame areas of difficulty and use patients' reports of cognitive difficulties as better indicators.

WHEN TO REFER?

Although neurologists and psychiatrists make most referrals for neuropsychological services,[5] internists, family practice physicians, and other primary health care professionals are often the first to see the indications of cognitive impairment.

TABLE 1

Clinical indications for neuropsychological assessment

Changes in memory
- Amnesia
- Poor short-term recall
- Frequently loses items
- Gets lost easily
- Fails to recognize familiar persons

Poor attention and concentration
- Doesn't appear to listen
- Gets confused in conversations
- Does poorly in complex situations

Changes in language functioning
- Aphasia
- Agnosia
- Dysfluency

Changes in visuospatial abilities
- Difficulty drawing
- Difficulty navigating (using a map or understanding directions)
- Misperceiving the environment

Impaired executive function
- Perseverative
- Poor judgment
- Rigidity in thought

Changes in emotional functioning
- Increased anxiety
- Increased depression
- Psychoses

Fluctuations in mental status
- Disorientation

A referral for neuropsychological evaluation should be considered any time there is a question about a patient's cognitive functioning (TABLE 1). Some common complaints that might signal a need for testing include:

- Short-term memory problems
- Losing items frequently
- Confusion
- An unexplained change in personality
- Poor decision-making
- Unexplained neurologic complaints
- Inability to care for finances
- Failure to recognize peers
- Language difficulty
- Poor attention and concentration.

In addition, a neuropsychological evaluation should be considered if there is a question

as to a patient's competency. The evaluation can provide evidence of a patient's ability to act purposefully, think rationally, and deal effectively with the environment.[2,3]

Specify what you want from the referral

When referring a patient for a neuropsychological evaluation, the physician should specify the diagnostic and functional questions that he or she is trying to answer. Referrals should address the areas of concern and the type of conclusions requested (eg, treatment planning, competency, functional limitations, diagnostic accuracy).

CASE CONTINUED

Ms. Smith was referred for a neuropsychological evaluation. The referring physician asked whether her neurocognitive deficits were consistent with a neurodegenerative process or were more likely the result of psychological disruption.

The evaluation showed that Ms. Smith had significant psychomotor slowing, impaired attention and concentration, mild memory impairments, and significant depressive symptoms, including fatigue, loss of appetite, and poor self-concept. The pattern of her performance was not indicative of a progressive neurodegenerative process.

Ms. Smith was referred for psychiatric consultation for medication management and for individual psychotherapy. She was encouraged to use memory aids during the interim, including notebooks to record important information.

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